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melanocephalus Fab. Riley county, June.
venatus Say. Riley county; St. George, June.
parvulus Gyll. Riley county, April, May, June; Johnson county, "May, working on corn."
destructor Chittn. Manhattan, June.
zeæ Walsh. Gardner, "working on corn."
callosus Oliv. Manhattan, July; St. George, July.
cultellatus Horn. Riley county, June, July, August, September; Rooks county, August.
compressirostris Say. Wallace county, July.
**minimus* Hart. Riley county, March, May.
germari Horn. Kiowa county, May; Manhattan, July.

Calandra Clairov.
oryzæ Linn. Riley county, February, August; Johnson county, November; Topeka; Winfield, August, on sunflower.
granaria Linn. Riley county, April, June; Hoxie, August.

SCOLYTIDÆ.

SCOLYTINÆ.

Scolytus Geoff.
quadrispinosus Say. Topeka, June, July; Riley county, August, in bitternut.
muticus Say. Riley county, May in hackberry, June in hackberry.
rugulosus Ratz. Cherokee, September; Wilder, August in apple.

IPINÆ.

Xylocleptes Ferran.
**cucubitæ* Lec. Ashland, June.

Xyleborus Eich.
xylographus Say. Topeka.

Phloeosinus Chap.
dentatus Say. Salina, March, mines in red cedar.

Hylesinus Fab.
aculeatus Say. Riley county, April, June, under bark in green ash.

Helium as a Balloon Gas.

HAMILTON P. CADY.

Helium being an absolutely inert gas chemically, and yet much lighter than air, is obviously an ideal balloon gas, provided it can be obtained in sufficient quantities at a reasonable figure and if it will stay in a balloon.

Helium is twice as dense as hydrogen, and hence has less lifting power, but not as much less as this ratio would indicate. One gram of hydrogen displaces 14.39 grams of air, and therefore will lift itself and 13.39 other grams, while 2 grams of helium will lift 12.39 grams in addition to itself; so the flotation of helium is 92½ per cent of that of hydrogen.

The question of the ability of balloon fabric to retain helium was one which gave much concern. Hydrogen escapes at a fairly rapid rate, and since helium is able to diffuse through hot quartz glass much faster than hydrogen, it would not be impossible for it to pass through balloon fabric as fast or faster than hydrogen, and this would be very serious, because helium inevitably costs more than hydrogen. Fortunately, it turned out that helium escaped only about half as fast as hydrogen.

The question of its availability, then, turns on its production in sufficient quantities at a low enough price. A little over twelve years ago Dr. David McFarland and I found that the almost noninflammable gas of the Dexter, Kan., field contained 1.84 per cent of helium, and since there were many wells each able to yield ten million cubic feet per day, here was an abundant source of the gas. We made an extensive investigation of other gases of this country and Canada and concluded that all natural gases contain some helium, but nowhere have gases been found as rich as those of the midcontinent field, especially certain portions of Kansas.

When our country entered the war the British government suggested that our government take up the problem of obtaining helium for balloons. The British were then at work trying to use the comparatively poor gases of Canada. The problem was apparently a simple one and could be solved by the same methods used for the separation of oxygen, nitrogen and argon from the air. In fact, in some ways it should be easier, because the difference in boiling points is greater. Helium boils at —268.5° C., while the nitrogen and methane which accompany it boil at —195° and —164°, respectively. In the air the boiling points are: oxygen, —182.5°; nitrogen, —195°; and argon, —186°. We were able to point out to those interested that the problem was complicated by the fact that, in our experience, helium is fairly easily soluble in liquid natural gas, and that this would have to be taken into account.

As the result of conferences in Washington the main problem was assigned to the Bureau of Mines, and by them apportioned to those who seemed best prepared to handle their "bit." The University of Kansas was asked to do the analytical work involved in the location of the most available source; to determine the solubility of helium in liquid methane, in liquid nitrogen, and in mixtures of the two; to prepare helium for the Bureau of Standards to use in the test of its permeability through balloon fabric (we later also made some experiments along this line); to determine the density of the helium as prepared, to see if the neon which was always present had an appreciable effect on its flotation, and also to determine how much hydrogen might be present in the gas without forming an inflammable mixture.

We found that the best available source which was ready developed and in use on a large scale was the wells at Petrolia, Tex., supplying Fort Worth. These ran 0.96 per cent, much lower than the Dexter, Kan., gas, but that supply was exhausted. The solubility was found to be so great that one-third or more would be lost if efficient fractionation were not arranged for in the process. Neon was present in too small quantities to appreciably affect the flotation. Ten per cent of hydrogen could be mixed with the helium without making a gas which could be ignited.

The Air Reduction Company and the Linde Air Products Company were asked to install experimental plants at Fort Worth to try to separate the helium. They did so. The Air Reduction Company uses the Claude process, which seems to lack the flexibility necessary for experimental purposes, and they were not successful in making concentration of helium. The Linde plant, after many changes, did produce highly concentrated helium in fairly large quantities at a cost of about $100 per thousand cubic feet. The Navy Department is now erecting a large plant to extract helium by the Linde process.

A third experimental plant has been erected at Petrolia, using a process worked out by Norton, a brilliant engineer with a very thorough knowledge of thermodynamics. His process is theoretically sound, but he had never been able to finance its development. Norton is a protégé of Cottrell, of the Bureau of Mines, and the latter insisted that Norton be given money to erect a plant. This is now in operation, and while it has as yet produced helium of no higher concentration than 16 or 17 per cent, its workings are being continually improved and the indications are that it also will be successful. The encouragement of the Norton process is Cottrell's chief contribution to the helium problem. Another man who contributed largely to the success of the undertaking was G. O. Carter, of the Navy Department, Bureau of Steam Engineering. He had formerly been associated with the Linde company, and I believe that his advice and experience were most helpful. Burrell, as head of the American University experiment station, had general charge of the whole problem, and was very efficient; but the man to whom probably the most credit belongs is Sir William Ramsay, who first suggested the use of helium for this purpose.

In our laboratory my chief assistant was C. W. Seibel. H. C. Allen, P. V. Faraghar, F. W. Bruckmiller and Emily Berger were also very active in the matter.

The Earth-Moon Theory.

LeRoy Hughbanks.

GENERAL INTRODUCTION.

Before beginning our discussion of the earth-moon theory it will perhaps be profitable for us to survey briefly a few general facts and characteristics of our moon.

In the following table the volume, surface, mass and density of the earth equals one.

Table of the Moon.

Siderial period	27 days, 7 hours, 43 minutes.
Distance fom the earth	237,300 miles.
Diameter	2,160 miles.
Surface	0.074.
Volume	0.00234.
Mass	0.0128.
Density	0.63.
Axial rotation	27 days, 7 hours, 43 minutes.
Force of gravity (fall)	2.48 feet in 1 second.
Velocity in orbit	2,273 miles per hour.

The moon has always been an object of beauty and interest in the nightly heavens. To the naked eye she presents a soft, silvery luster, and many are they who in ages past have worshiped at her shrine. Old Omar of the East paid homage to her in his poetry, and many another in later days have sung of her transcendent glory.

There are a few mountain chains, hundreds of hills and valleys—numerous systems of radiating streaks—and over thirty thousand ring mountains of all sizes from a mile in diameter to sixty times that.